The Lymphatic System

The lymphatic system consists of a protein-containing fluid called lymph, lymphatic vessels, lymph nodes, and lymphatic tissues and organs such as the spleen, thymus glands, and tonsils.

Functions

1. Lymphatic vessels collect and transport the excess lymph in the spaces between the tissues which was forced out of blood capillaries at the arteriole end and not taken back in at the venule end.
2. Lymphatic organs produce lymphocytes, phagocytic cells, and antibodies that help the body defend against disease.

Lymphatic Vessels

Lymphatic vessels originate as closed-ended lymphatic capillaries that extend into the spaces within most tissues (interstitial spaces), forming complex networks that parallel the networks of blood capillaries. Lymphatic capillaries form a one-way system in which lymph flows only toward the heart and they are found in all tissues and organs except in the central nervous system, bone marrow, bone, and teeth. The walls of the lymphatic capillaries consist of a single layer of endothelium in which the cells overlap and form flap-like minivalves. Bundles of filaments from the minivalve attach to the cells of surrounding tissue and pull the flaps open when the fluid in the tissues is high and fluid enters the lymphatic capillary.

Lymphatic capillaries merge to form larger, thicker walled lymphatic collecting vessels. The collecting vessels are similar to veins and have three tunics, but they are thinner and they have more valves. Contraction of skeletal muscles around the vessels, pressure changes during breathing, and the presence of valves that prevent the backflow of lymph, aid in moving the lymph through the collecting vessels.

The lymphatic collecting vessels lead to the lymph nodes. Clusters of lymph nodes are found along the lymphatic collecting vessels. The major lymph nodes occur in the cervical (neck), axillary (arm pit), and inguinal (where the leg joins the trunk) regions. Each lymph node is covered by a capsule of dense fibrous connective tissue. Portions of the capsule extend inward forming strands called trabeculae which divide the node into compartments. A network of reticular fibers form an internal framework, or stroma, which supports the lymphocytes.
The lymph node has two distinct regions:

1. **cortex** - outer region of densely packed spherical collections of lymphocytes called **follicles**. Within the follicles are **germinal centers** where T lymphocytes are found and where B lymphocytes divide by mitosis to form **plasma cells**.

2. **medulla** - inner region where lymphocytes and plasma cells are attached to cord-like extensions of the reticular fibers from the cortex known as **medullary cords**.

From the lymphatic collecting vessels, lymph enters the lymph nodes through **afferent lymphatic vessels**. The afferent lymphatic vessels pass through the capsule to a large **subcapsular sinus**. From the subcapsular sinus, lymph flows through numerous interconnected sinuses in the cortex and into the medulla. The lymph then leaves the lymph nodes by way of the **efferent lymphatic vessels**. The efferent lymphatic vessels leave the lymph node from an indented region called the **hilus** and merge to form the larger **lymphatic trunks**. The lymphatic trunks collect lymph from various regions of the body and are named for the regions they drain (jugular, subclavian, intestinal, lumbar),

The lymphatic trunks join to form one of the two **lymphatic ducts**.

1. **right lymphatic duct** - drains lymph from the right side of the head, neck, and thorax, and the right upper arm. The duct opens into the right subclavian vein near where it joins the right jugular vein.

2. **thoracic duct** - it is larger and longer than the right lymphatic duct and receives lymph from the lumbar and intestinal trunks. The lymph is collected in a sac located in the lumbar region known as the **cisterna chyli**. Superior to the cisterna chyli, the thoracic duct receives lymph from the left side of the head, neck, and thorax, and the left upper arm. The duct opens into the left subclavian vein near where it joins the left jugular vein.

**Lymphatic Organs and Tissues**

**Spleen**

The spleen is the largest lymphatic organ and it is located in the upper left portion of the abdominal cavity, just behind the stomach and below the diaphragm. The spleen is surrounded by a fibrous capsule and trabeculae extend inward from the capsule but do not divide it into compartments.
Two types of tissue are found in the spleen.

1. **white pulp** - It carries out the immune functions of the spleen and consists of lymphocytes suspended on reticular fibers and clusters of lymphocytes form around the branches of the splenic artery.

2. **red pulp** - It consists of venous sinuses surrounded by reticular connective tissue which contains erythrocytes and macrophages. The red pulp removes worn-out red blood cells and platelets, bacteria, viruses, toxins, and other foreign substances from the blood.

**Thymus Gland**

The thymus gland is similar to the lymph nodes and spleen except epithelial cells replace the reticular tissue. Connective tissue divides the thymus into lobules, each containing a cortex and a medulla. Some of the lymphocytes develop into T lymphocytes which leave the thymus and migrate to other lymphatic tissues. The thymus gland grows and is most active during childhood and stops growing during adolescence. It atrophies and by old age it is replaced by fibrous and fatty tissue.

**Tonsils**

The tonsils are lymphatic tissue found in the mucosa of the pharynx. There are four pairs of tonsils which are named based on their location.

1. **palatine tonsils** - they are the largest and are located on either side of the posterior oral cavity.
2. **lingual tonsils** - they are located at the base of the tongue.
3. **pharyngeal tonsils or adenoids** - they are located in the posterior wall of the nasopharynx.
4. **tubal tonsils** - they are the smallest tonsils and they are located around the openings of the Eustachian (auditory) tubes in the pharynx.

The tonsils contain nodules with germinal centers which are surrounded by widely scattered lymphocytes. The epithelium indents deeply to form pockets or crypts which trap bacteria and pathogens that enter the pharynx in food or water or inhaled in air. Immune cells are formed which have a "memory" for the pathogens and activate the immune system against the pathogen if it is encountered later in life.
Mucosa-Associated Lymphatic Tissue (MALT)

MALT consist of the tonsils, lymphoid nodules in the appendix, and Peyer's patches in the small intestine. They capture and destroy bacteria, fungi, and other foreign substances which protects the respiratory and digestive tracts from invasion.